Computer Architecture
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Homework 1

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EX 1.

(a)

To compute the speedup obtained from the fast mode we must work out the execution time without the enhancement. We know that the accelerated execution time consisted of two halves: the unaccelerated phase (50%) and the accelerated phase (50%). Without the enhancement, the unaccelerated phase would have taken just as long (50%), but the accelerated phase would take 3 times as long, i.e. 150%. So the relative execution time without the enhancement would be 50% + 150% = 200%,

Thus the overall speedup is,

$$\frac{execute_{original}}{execute_{accelerate}} = \frac{200\%}{100\%} = 2$$

(b)

To find the percentage of the original execution time which was accelerated, we plug these figures into Amdahl's Law again:

$$fraction = \frac{speedup_{overall} \times speedup_{accelerated} - speedup_{accelerated}}{speedup_{overall} \times speedup_{accelerated} - speedup_{overall}} = \frac{2 \times 3 - 3}{2 \times 3 - 2} = 0.75$$

EX 2.

(a)

According to Amdahl's law, we have:

$$\begin{aligned} speedup_{overall} &= \frac{1}{1 - 0.3 + \frac{0.3}{3}} \\ &= 1.25 \end{aligned} \tag{1}$$

(b)

$$\begin{aligned} speedup_{overall} &= \frac{1}{1 - 0.1 - 0.3 + \frac{0.1}{\frac{1}{2}} + \frac{0.3}{3}} \\ &= 1.11 \end{aligned} \tag{2}$$

So, the actual speedup is 1.11

(c)

The percentage of execution time spent on floating-point operations is:

$$\frac{0.3/3}{0.6 + 0.3/3 + 0.1 \times 2} = 0.111 \tag{3}$$

The percentage spent on data cache accesses is:

$$\frac{0.1 \times 2}{0.6 + 0.3/3 + 0.1 \times 2} = 0.222 \tag{4}$$

EX 3.

(a)

$$\begin{aligned} speedup_{overall} =& \frac{1}{0.5 + \frac{0.5}{2}} \\ =& 1.33 \end{aligned} \tag{5}$$

(b)

$$\begin{aligned} speedup_{overall} =& \frac{1}{0.2 + \frac{0.8}{2}} \\ =& 1.67 \end{aligned} \tag{6}$$

(c)

$$\begin{aligned} speedup_{overall} =& \frac{1}{0.4 + 0.6 \times (0.5 + \frac{0.5}{2})} \\ =& 1.18 \end{aligned} \tag{7}$$

(d)

$$\begin{aligned} speedup_{overall} =& \frac{1}{0.6 + 0.4 \times (0.2 + \frac{0.8}{2})} \\ =& 1.19 \end{aligned} \tag{8}$$

EX 4.

(a)

$$\begin{aligned} speedup_{overall} =& \frac{1}{1 - 0.8 + \frac{0.8}{N}} \\ =& \frac{1}{0.2 + \frac{0.8}{N}} \end{aligned} \tag{9}$$

(b)

$$\begin{aligned} speedup_{overall} =& \frac{1}{1 - 0.8 + 8 \times 0.01 \frac{0.8}{8}} \\ =& 2.63 \end{aligned} \tag{10}$$

(c) The number of processor is doubled three times in order to have 8 processors,

$$speedup_{overall} = \frac{1}{1-0.8+3\times 0.01\frac{0.8}{8}} \tag{11}$$
$$=3.03$$

(d) To reach N processors, the number of doubling is $log_2 N$

$$speedup_{overall} = \frac{1}{1-0.8+log_2 N\times 0.01\frac{0.8}{N}} \tag{12}$$

(e)

$$speedup_{overall} = \frac{1}{1-0.01P+0.01log_2 N+\frac{0.01P}{N}} \tag{13}$$

To get the number of processors with the highest speedup, the derivative (on N) of the speedup should be 0. Therefore, the equation is $\frac{0.01}{Nln2} - \frac{0.01P}{N^2} = 0$, and then the equation can be solved to have $N = 0.01P \times \frac{ln2}{0.01} = Pln2$